

# beaufort

February, 1982



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## Contents:

Progressive Technical Development .....	3
The Colourful History of the Northwest Passage .....	4
Facts and Fables about Four Centuries of Exploration	
The Manhattan .....	9
First Icebreaking Tanker through the Northwest Passage	
Ringed Seals .....	12
A Key Arctic Marine Mammal	
Profile of an Arctic Tanker .....	15
REMSCAN .....	19
The Eyes and Ears of Arctic Tankers	
Icebreaker Track Research Program .....	22

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**The Editor  
Beaufort  
Box 200,  
Calgary, Alberta T2P 2H8**

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**Cover Photograph** - Dome Petroleum's prototype icebreaker, the Kigoriak, has provided marine designers with invaluable experience for the Arctic tanker. Many of its features, such as a spoon shaped bow and reamer, water spray system, and power train have been tested in the demanding environment of the Arctic for the first time. With the knowledge gained from Kigoriak, modifications can be made on the next generation of ships, Supplier 9, to test out improvements and refinements. Following this progressive technical development will lead to the Arctic Class 10 icebreaking tanker.

Beaufort is published by Dome Petroleum Limited, Esso Resources Canada Limited and Gulf Canada Resources Inc. to provide the general public, and interested parties, background information on the long range development and production of hydrocarbons from the Beaufort Sea and Mackenzie Delta. In terms of engineering and technical skills production is attainable in this region by the mid-80s. Before approval in principle is obtained from the federal government, a detailed report on the possible effects and impacts of such production must be prepared. This report, known as the Environmental Impact Statement, is to be completed in the spring of 1982. The E.I.S. will address the issues and concerns raised by the production scenario. BEAUFORT will report on the progress of the E.I.S. and the energy industry's evolving plans to address these concerns.

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## Progressive Technical Development

In various articles of Beaufort Magazine, the phrase "progressive technical development" may be used. Simply defined, it means developing technical solutions by building upon the experience gained through planned, experimental and/or operational stages. This issue of Beaufort deals with Arctic tankers and illustrates the progressive technical development philosophy.

Work towards the Arctic tanker started when the oil industry's first ships, such as the Manhattan, drillships, and the Class 2 supply boats entered the Arctic. This was followed by the John A. Macdonald icebreaker work in 1978, extensive ice tank testing as a precursor to the Kigoriak, and then experience with the ship itself. The Kigoriak has now completed two years of work in the Beaufort Sea.

Based on new knowledge gained, a ship originally called the Supplier 9, now named the Robert LeMeur, is being built in Vancouver. She incorporates many advancements. Arctic class dredges and other icebreakers presently in the advanced design stage will test the year-round capabilities required for Arctic tankers. This will culminate in the testing of an Arctic tanker, first without an oil cargo, to confirm the final criteria implied in progressive technical development.

### FEARO Update

Public meetings on the draft Beaufort Sea Environmental Assessment Guidelines were held in Calgary, and nine centres throughout the North during November and December, 1981. From these meetings a diversity of local viewpoints, group submissions and questions were heard by the Environmental Assessment Panel, chaired by Dr. John Tener. The Panel is presently incorporating the advice and opinions expressed into a final set of guidelines for the En-



vironmental Impact Statement. These guidelines are expected to be released to the proponents and the public by the end of February, 1982.

### Letters & Requests From Our Readers

We are receiving many requests asking to be added to the Beaufort Magazine's complimentary mailing list. Our circulation is now fast approaching the 10,000 mark. Inquiries have come from private individuals, corporations, consulting firms, not to mention many university and government departments. International requests have arrived from Holland, the United States, Great Britain, Japan and Australia.

Recently we received a letter from Cecile Suchal, of Ottawa, Ontario, asking for a translation of the names of the industry's artificial islands, drill sites, and marine equipment. These names are drawn from the Inuit language and we list some translations below:

**Tarsiut**.....night hawk.  
(Gulf/Dome's most recent man-made exploration island).

**Kigoriak**.....northern lights  
(icebreaker)

**Issungnak**.....Arctic Jaeger  
(Esso/Gulf's man-made exploration island).

**Kopanoar**.....Snowbird  
(a deep water oil and gas discovery).

**Koakoak**.....Raven  
(a deep water oil and gas discovery commonly pronounced "Quack-Quack").

Several readers have also asked about having bylines for all articles. We have not done this because the stories in Beaufort are written and then re-drafted several times by a variety of experts drawn from the proponent companies, Dome, Esso, and Gulf.

The basic research and first draft writing is provided by Wayne Ralph, who is on assignment to Beaufort Magazine, and was formerly editor of Wings Magazine and Helicopters In Canada. All scripts are sent to the appropriate specialists in Dome, Esso, and Gulf to be checked for technical accuracy prior to publication.

The majority of photographs and drawings in Beaufort come from company sources, or are borrowed from historical archives, or individuals active in the field of Arctic research. Photographs from outside sources are credited, whereas stock, file photographs from Dome, Esso, and Gulf generally are not.

### The Purpose of Beaufort Magazine

Beaufort Magazine was created, as pointed out in our first issue, to provide timely and informative reading material on the oil industry's activities in the Beaufort Sea and Mackenzie Delta region of Canada. It is aimed at the general public and non-technical reader.

Our readers are encouraged to write in and express their views on our stories, and the ongoing Environmental Assessment and Review Process. The magazine is viewed as being not only educational in content, but as a forum for opinions from all sectors of Canadian society. Letters have been flowing in, and we look forward to seeing this continue.

# THE COLOURFUL HISTORY OF THE NORTHWEST PASSAGE

Facts and Fables  
About Four Centuries  
of Exploration

*Many explorers spent the long Arctic winter months frozen in the ice, sometimes making overland journeys during this period to map the terrain. Expeditions often suffered terribly from scurvy, caused by a deficiency of vitamin C, which made the skin turn black, the gums rot, and teeth fall out. Often the most successful explorers applied the experience of native Northerners, thereby avoiding malnutrition and frostbite. This artist's sketch is of HMS Assistance and Pioneer frozen in their winter quarters. (Courtesy of The Arctic Institute of North America, University of Calgary).*





It would not be stating it too strongly to say that the two explorers who entered the history books as discoverers of North America, Christopher Columbus and John Cabot, were perhaps surprised, and a little disappointed, not to have found the Orient. They had sailed westward hoping to reach China, but instead found a vast wilderness blocking their path. They, and centuries of explorers after them, searched for a pathway through North America to the Far East - a seemingly mythical Northwest Passage which legend said existed, but no one could find.

After the inevitable truth sunk in that no river or ocean channel cut through the centre of North America, speculators turned their attention to the North polar region. Cartographers of the 16th century illustrated the northern oceans rather creatively, believing that sea ice existed only along shorelines,

and would not form in deep, open waters. This encouraged a belief that there were navigable channels in the Polar regions which might lead to China. Even in the 16th century they were aware that the shortest distance from Europe to the Orient would be over the top of the globe, not around its equatorial middle.

The first explorer who searched for the Passage was Martin Frobisher, a former pirate, who sailed west in the summer of 1576 to secure a place in history. His first landfall was Resolution Island, located at the southern tip of Baffin Island. Discouraged by the swiftly flowing ice pack pouring out of Hudson Strait, he sailed northward into a channel which he modestly named after himself, believing that he had found the Northwest Passage. It was only a long bay in Baffin Island.

Unfortunately, Frobisher's efforts

to find the Passage were waylaid after he thought he had discovered gold. He expended great energy bringing home pyrite or fool's gold, and kidnapping Eskimos for the entertainment of London society. The Eskimos died, some say because of the English diet, and tons of pyrites were dumped into the harbour. After three seasons of exploration Frobisher gave up and went back to fighting wars with England's enemies.

Later explorers such as John Davis and Henry Hudson added significantly to European knowledge about Canadian northern geography, but were unable to find the Northwest Passage. Hudson came to a bad end in Hudson Bay - the crew of his ship, *Discovery*, mutinied and put him over the side in a small boat, along with his seven-year-old son and a few sailors. By most accounts the mutiny was justified, and the

*Wooden ships were surprisingly resistant to ice pressures, but often were jammed in by the ice floes, riding up onto the surface of the pack. This artist's sketch was published in Harper's Weekly in June, 1875, and is entitled "An Ice Nip in Melville Bay of Devil's Thumb." (Courtesy of The Arctic Institute of North America, University of Calgary).*



Discovery was fortunate to get back to England under the skilled navigation of a Robert Bylot.

Bylot, exonerated by a court martial for his mutinous actions, returned to the Arctic regions with the same ship, Discovery, and an excellent first mate and navigator named William Baffin. He mapped all the waters and coastline between Greenland and Canada in the spring and summer of 1616. Unfortunately, he sailed past Lancaster Sound, the eastern entrance of the Northwest Passage, perhaps because it was ice choked at that time of year.

Today there is a large island at the southern entrance to the Passage, near the community of Pond Inlet, named in Bylot's honour. But it took two more centuries before anybody else sailed westward into the Lancaster Channel. During those two centuries ambitious, romantic (but often foolish) explorers continued their attempts. Many hoped to find a channel run-

ning west to the Pacific out of Hudson Bay; all proved futile.

Later explorers such as Samuel Hearne and Alexander Mackenzie tried to find the Passage by land rather than sea, trekking over vast wilderness in a northward direction, hoping fervently to stumble across a riverway, an ocean, or channel leading west to the Pacific.

In 1778 the famous Pacific explorer, James Cook, sailed from the west through the Bering Sea, around the apex of Alaska, and into a formidable field of polar ice that crowded right up against the coastline. Cook's report said that there was no hope of finding a Northwest Passage from western approaches, and that the seas north of 70 degrees latitude were permanently frozen and useless for commerce.

Interest in the Northwest Passage waned following this respected opinion, and revived only in the 19th century due, in part, to large prizes offered for northern exploration. The British Parliament of-

ferred considerable sums of money for westward travel at high latitudes. Explorers were promised 5,000 pounds for reaching 110 degrees West longitude above the Arctic Circle, 10,000 pounds for getting to the longitude of the Mackenzie Delta, 15,000 pounds if they attained the present-day position of Prudhoe Bay, Alaska, and 20,000 if they made it all the way to the Pacific Ocean.

Captain John Ross took up the challenge in 1818. He retraced much of the route sailed by Bylot and Baffin two centuries earlier, praising them for their navigational skills and mapping accuracy. But unlike them, Ross turned westward into Lancaster Sound - the first, albeit unknowingly, to enter the Northwest Passage. He did not sail far into the Sound before observing a range of mountains stretching north to south - he named them Croker's Mountains. They did not exist - they were an Arctic mirage, common enough to experienced northern

*The islands and passages of the Canadian Arctic are dotted with historical landmarks, named for well known figures of the 19th century, or the brave explorers who first mapped this harsh region.*



inhabitants, but looking no less formidable a barrier to Ross.

He turned back and was later much maligned in England for this seemingly timid action. His deputy commander on that first voyage, William Parry, returned to Lancaster Sound in 1819 and kept sailing west, naming places and waterways as he progressed (Wellington Channel after the Duke of Wellington, Cornwallis Island after the first admiral he had served under).

There is a point of land on the southern edge of Melville Island called Cape Bounty - named by Parry because it was at approximately 110 degrees West longitude, and entitled him to the first 5,000 pound reward. That year he actually made it to 112 degrees, 51 minutes West before the pack ice became impenetrable. Returning to Melville Island, he set up camp for the winter, naming the camp Winter Harbour. Ironically this is near the spot where, in 1961, the first Arctic well was drilled by Dome et al.

The following year, 1820, Parry's expedition got as far west as the mouth of M'Clure Strait (113 degrees, 46 minutes). That record was not bested until the Manhattan's voyage in 1969 when it made it to

117 degrees, 30 minutes. Ice conditions vary considerably in the Passage from year to year. It is quite possible that the ice in M'Clure Strait was light in 1820, explaining Parry's success in reaching to within 200 miles of the Beaufort Sea in small, wooden ships.

Certainly he was not able to duplicate the feat in later expeditions and therefore turned to a southern routing close to the Canadian mainland. Many expeditions in northern Canada suffered terribly from scurvy, caused by a lack of Vitamin C. However, Parry was an intelligent and enlightened commander and fed his sailors a diet supplement of mustard plants and watercress, which he had grown in boxes placed on the ship's heating pipes.

By contrast, John Franklin's expedition of 1845 was a tragic, nightmarish experience in which all 139 men died from exposure and starvation. This fate could have been avoided had they applied the lessons of Parry and learned to live off the land. More than 40 explorers searched for the Franklin expedition over a ten-year period. One searcher was Robert M'Clure, who attempted to penetrate the Beaufort Sea from

the west in 1850, making it to Banks Island, from where he could observe the shores of Melville Island where Parry had wintered.

His ship could not make it through the thick ice of Prince of Wales Strait, but M'Clure was the first to see with his own eyes that the Northwest Passage existed. While frozen in at Mercy Bay on the north shore of Banks Island in 1852 and 53, he visited Winter Harbour. Therefore, M'Clure goes down in history as the man who proved that the Passage was a reality and not a myth. He never realized his dream to navigate it, but his experiences seemed to prove conclusively that the Passage was not navigable and not commercially viable.

The Franklin expedition spent three years in the Arctic, frozen in the first winter on Beechey Island in the Passage. Three of Franklin's men died there and their grave sites are visible today on the small, rocky island. Their second winter was spent frozen in near King William Island, next to the Canadian mainland. John Franklin died in June of 1847, and a large contingent of the expedition, suffering from malnutrition, decided to trek overland to a Hudson Bay post

*This is Nelson Head, the southern tip of Banks Island, and western entrance to the Northwest Passage via Prince of Wales Strait. Many of the islands, particularly in the eastern section of the Passage, have mountains which soar to over 6,000 feet.*





*This photo illustrates the rugged Devon Island coastline along the eastern entrance to Lancaster Sound and the Northwest Passage.*

more than 1,000 miles away.

For unknown reasons the men dragged boats on sleds behind them. These boats were packed full of goods and materials including

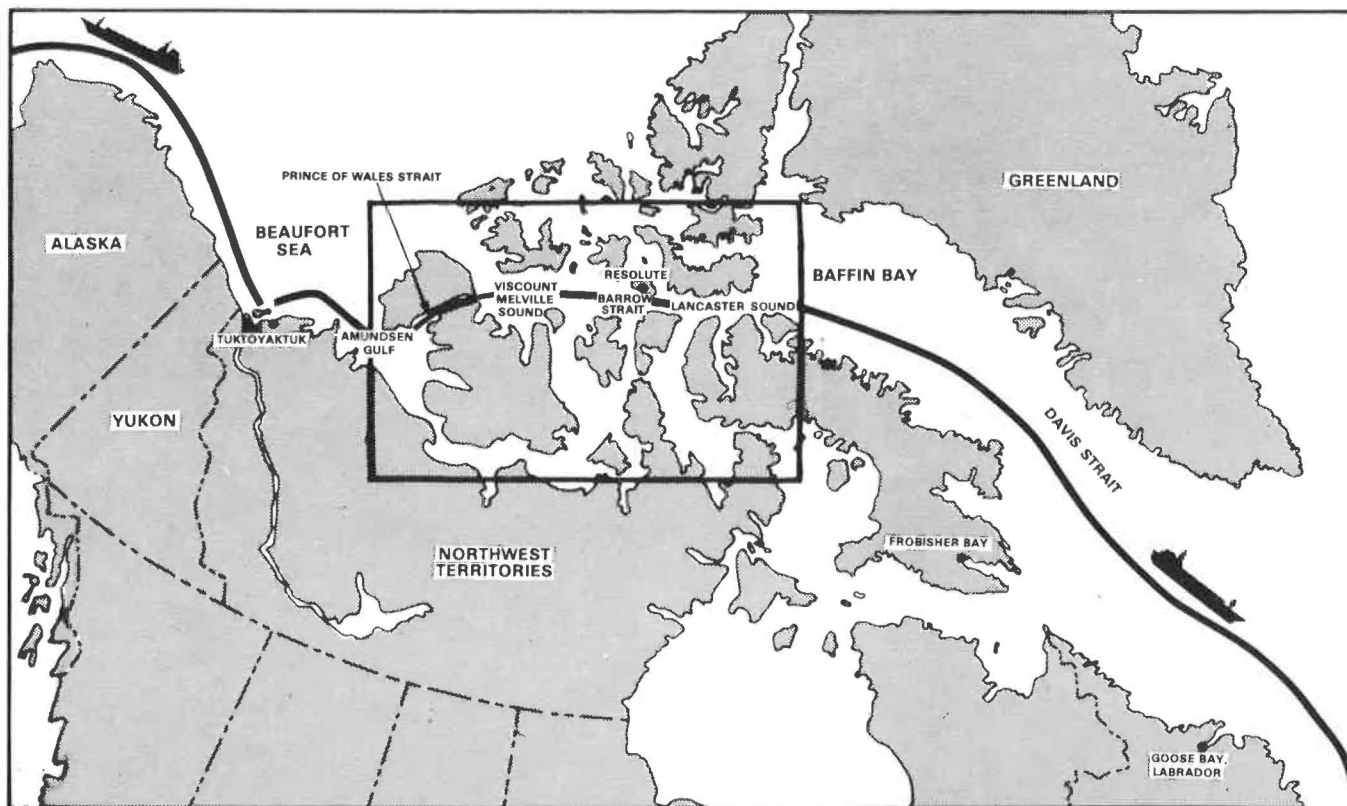
"civilized" property such as silver table service, not terribly useful for Arctic survival. The searchers who discovered the remains of the expedition found evidence that as

food dwindled, the men of the Franklin expedition resorted to cannibalism. About 40 of 105 men made it as far as the Canadian mainland, where they died on the shores in the winter of 1848-49.

When the commercial value of a Northwest Passage seemed questionable, most explorers turned their efforts elsewhere. In the years from 1903 to 1906 Roald Amundsen's herring boat, the *Goja*, made an east to west navigation of the Canadian Arctic, but not via the formidable Viscount Melville Sound and Prince of Wales Strait. Rather he hugged the Canadian mainland channels south of Victoria Island, entering the Beaufort Sea from the direction of Coronation Gulf, and Dolphin and Union Strait.

It would take the voyage of the converted tanker, *Manhattan*, to bring to life the centuries-old dream of a commercial route to the Pacific, nearly four hundred years after Frobisher sighted Resolution Island.

*This map illustrates the position of the Northwest Passage in relation to the rest of Canada, illustrating the general routing that icebreaking tankers would take beginning in the latter part of this decade, following the historic routing of the early explorers.*





# THE MANHATTAN



## First Icebreaking Tanker Through The Northwest Passage

Following the discovery of the giant Prudhoe Bay, Alaska oil field in 1968, the Humble Oil and Refining Company, a subsidiary of Exxon Corporation, examined the possibility of transporting oil in icebreaking tankers via the Arctic waters of the Northwest Passage. There was no practical experience of tankering in Arctic waters and, in fact, no commercial vessels had ever sailed through the Passage.

Only a few ships of any type have accomplished this feat - the first being Roald Amundsen's 47-ton herring boat, Gjoa. In 1944 the RCMP schooner, St. Roch, transited the Passage from east to west in one season, and in 1954 the first

deep draft vessel, the CGGS Labrador, also made the journey. A few U.S. and Canadian Coast Guard vessels have accomplished the trip since then, as has the drillship Canmar Explorer II and the prototype Kigoriak icebreaker. But the SS Manhattan, specially modified for the purpose, was the first commercial tanker to make it through.

The Manhattan was well suited to being modified for icebreaking duties. In 1968 she was the largest twin screw oil tanker in the world, 106,000 DWT, and had the highest installed horsepower, 43,000 SHP, of any merchant ship of that class. She had originally been built with

thicker steel than that used in later tankers, and the steel in her deck and upper hull had better low temperature characteristics.

Esso International, Inc. was responsible for the Manhattan's conversion, which was accomplished in a remarkably short period. The ship was cut into four pieces and the welding work was farmed out to four different shipyards. At the end of February, 1969 the Manhattan was split up; by late August that year she sailed for the Northwest Passage.

About 9,200 tons of steel were added to the tanker. Her length was increased from 286 metres (940 feet) to 306 metres (1,005 feet), the

conventional bow being replaced by a shallow stem angle, icebreaking bow. An external ice belt was welded along each side of the hull's mid-section, and the cargo tanks were internally strengthened to withstand the compression loads caused by pack ice.

The area around the boiler and engine rooms was provided with an internal double skin, to protect this critical region from puncture by ice. This decision proved to be a wise one because a hole was punctured through the outer hull into the steering gear room on the Manhattan's second Arctic voyage. The inner skin was not pierced and contained the flooding waters so that the voyage could continue.

Two new propellers with thicker blade sections and higher strength steel, coupled with redesigned and stronger propeller shafts and shaft

supports, were fitted, so that the Manhattan could withstand high shock loadings caused by milling ice.

To allow the ship to break loose from dense ice, a heeling or rolling system was added. Two 1,000 horsepower bow thrusters were installed into 2 metre (80 inch) diameter tunnels between two Wingtanks. They were driven by diesel engines housed on the main deck. They could only heel the Manhattan a modest 1½ degrees either side, but this helped reduce ice friction when stopped.

A large instrumentation trailer was fitted under the starboard bridge wing, housing computer tapes which recorded many types of performance data, such as ship motion and acceleration, hull strain, and weather conditions. During the voyages, scientists took frequent ice

core samples, water temperatures and other important measurements. This was the first scientific attempt to appraise ice forces on a large vessel, in a real-world rather than laboratory setting.

### The Northwest Passage

The Manhattan sailed down the Delaware River on August 24th, 1969. By September 1st she was in Baffin Bay, joined up with her Canadian escort, the icebreaker John A. Macdonald. The United States Coast Guard icebreaker, Northwind, joined the group during a brief stop at Thule, Greenland, at which time the Manhattan's propellers were checked for ice damage (none existed). It was apparent early in the voyage that the great mass of the Manhattan, as well as her downward breaking

*The breadth and draft of the Manhattan, coupled with her tonnage, made her an excellent icebreaker in thick ice. Her journeys in the Passage were the first large scale testing of the icebreaking tanker concept, and provided invaluable data for the new generation of tankers of the 1980s.*



bow, made her a very effective icebreaker. She was able to tackle thick ice that conventional icebreakers needed to manoeuvre around.

However, the Manhattan's escorts were essential because she could not generate more than one third power in reverse, a common problem with turbine driven, conventional tankers. The escorting icebreakers, being more nimble and having 100 percent reverse power, were used to break the ice on the side of the Manhattan, allowing her room to back up and take another run.

At first she attempted to exit the Northwest Passage via M'Clure Strait, but was unsuccessful. This strait, north of Banks Island, generally has very severe icing conditions because the prevailing westerly winds blow polar pack ice from the Beaufort Sea into the 300 kilometre (220 miles) long channel. The Manhattan back-tracked and

sailed south through the less ice-bound Prince of Wales Strait to Amundsen Gulf, the Beaufort Sea, and finally Point Barrow, Alaska.

That year the Manhattan also sailed west to east through the Passage on its return trip.

### Lessons Learned

As mentioned earlier, the benefits of having a double hull for Arctic operations were well demonstrated on the Manhattan's second voyage. The areas where the single hull was not reinforced did sustain some damage, and one large hole was punctured by ice in the starboard wing tank forward of the bridge - this latter hole occurred in relatively open waters in the Davis Strait, heading south after the first year's voyages. It confirmed what experienced Arctic mariners have known for years - some of the most severe damage can occur while proceeding quickly in waters in-

festated by growlers and bergy bits.

Problems encountered by the Manhattan became lessons learned and were largely due to the ship's conventional origins. Hull damage was due to inadequate hull strength in the parts that were not reinforced. Low astern power, typical of her class, resulted in inability to back up after ramming very thick multi-year ice.

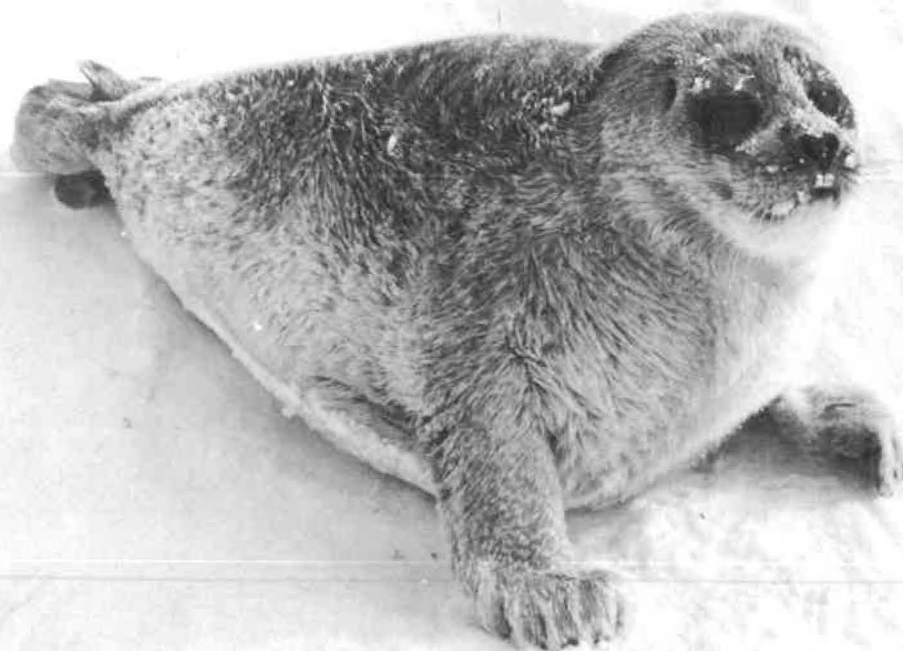
These first voyages demonstrated the feasibility of using icebreaking tankers to carry Arctic oil to market. The original dream of centuries of explorers was a Northwest Passage to the fabled Orient. Unfortunately for those brave men, they did not have a vessel of the Manhattans power to make their dream come true. But in this decade the experience gained with the Manhattan is being applied to a new generation of vessels which will make commercial traffic in the Northwest Passage a reality.

*The bow of the Manhattan was removed for her icebreaking trials, and replaced by a shallow stem angle, icebreaking bow, which proved to be quite effective. Following the trials the ship was not converted back because it was found that there was very little change in her cruising speed in open water because of the modified bow.*



# RINGED SEALS

## A Key Arctic Marine Mammal



*A young ringed seal on the ice. They are cared for by their mothers until about two months old, at which time they have built up a fat layer which protects them against the elements. (Photo courtesy I. Stirling, Canadian Wildlife Service).*

Seals belong to a biological order called Pinnipedia which translated literally means "fin footed". There are two main family divisions each with its own unique characteristics. Fur seals, sea lions, and walruses are in one family, distinguished by their small external ears and different method of locomotion. In the water they swim with their front flippers, but on land are capable of flexing their front and back flippers to move around. True seals, which include the ringed seal, have no external ear flap, use their back flippers to swim, but use only their front flippers, with an assist from their bodies, to move around on land. Ringed seals have hair covered flippers unlike walruses and sea lions.

All told there are about 32 species of seals. They are found in all oceans of the world but are most

abundant in the cold waters of the Arctic, Antarctic, and temperate coastlines characterized by cold currents such as the west coast of North America. The ringed seal is one of the smallest species, weighing about 60 to 70 kilograms (132 to 154 pounds) and measuring approximately 1¼ metres (4 to 5 feet) in length. By comparison elephant seals can weigh 3,600 kilograms (8,000 pounds) and measure 6 metres (20 feet) in length. The ringed seal is the most widespread marine mammal in the Canadian Arctic and is a permanent resident from the Alaska coastline on the west to northern Newfoundland in the east, south into James and Hudson Bay, and as far north as the Pole itself. Ringed seals are relatively sedentary, tending to remain in a particular area most of the time.

During the winter adult ringed seals prefer to concentrate in or near stable, fast ice areas. Therefore they are generally coastal in distribution where the ice is most stable. However, the species can also be found far offshore in zones of moving pack ice but usually in fewer numbers. The total world population of the species is uncertain, with estimates ranging from two to six million. Surveys conducted in the Beaufort Sea region from 1974 to the present by C.W.S. have reported a population estimate ranging from 21,000 to 60,000. However, this represents only seals seen on the ice - we do not know what percentage this is of the total population. Research has shown that the population can fluctuate greatly from year to year due mainly to natural variations in ice conditions.

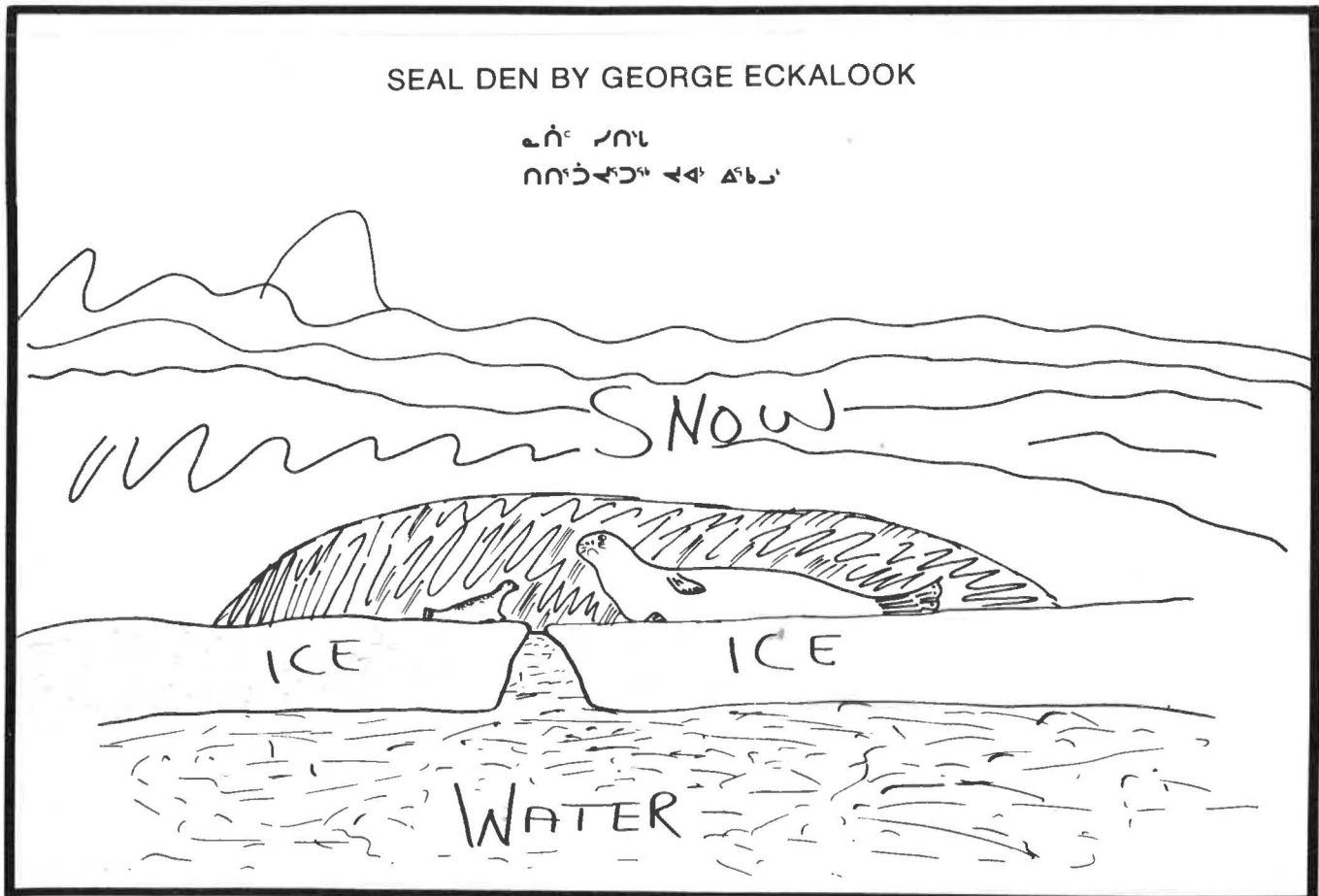


The majority of pups are born during the first two weeks of April, though the pupping season may extend from March to May. Pups are born in lairs usually hollowed out of snow drifts in the lee of pressure ridges and in hummock fields on or near stable fast ice. They weigh about 4½ kilograms (10 pounds) at

Pup survival is dependent upon several factors in the first few months. In the early period following birth pups avoid the water because their fur gets soaked and is slow to dry out. They can shiver to generate heat - adult seals do not shiver because they don't need to - their body fat and temperature control mechanisms are a well developed shield against the cold. Until their fat layer is developed pups shiver automatically to keep warm. Seal pups absorb large quantities of their mother's milk which is rich in fat. This builds up their own thick fat layer and within a few weeks the snow-covered lair is no longer needed to keep warm, since the pups have acquired all the protec-

Seals rarely have to increase their metabolic rate to keep warm, and they do not decrease their internal body temperature as the external temperature drops. They do not, like many other mammals, have to eat more to maintain heat in extreme cold.

Ringed seals have a varied diet





*Bearded seals basking on the ice in spring, near McKinley Bay in the Beaufort Sea. This species, although less common than ringed seals, is larger and also important to the native harvest.*

which includes fish like the polar cod and shrimp-like crustaceans, such as mysids and amphipods, which are 2 to 7 centimetres ( $\frac{3}{4}$  to  $2\frac{1}{2}$  inches) long. These seals can dive to depths of 100 metres (over 300 feet) to seek food, and swim at speeds up to 25 kmh (15 mph) for short periods. How deep ringed seals can dive is uncertain, although some other species have been seen at depths of 600 metres (over 1,950 feet) and some have stayed submerged for up to 70 minutes!

A seal has about  $1\frac{1}{2}$  times the blood volume of a similar sized land mammal, and it is rich in a component called myoglobin which carries oxygen. The myoglobin gives seal meat its dark red colouration. Seals can slow down their heartbeat when diving to about 10 beats per minute from a normal level of nearly 150 beats a minute, and restrict the bloodflow to their muscles. A minimum flow of blood is provided for essential organs and the brain. This underwater adaptation allows seals to stay submerged without oxygen for remarkable periods, without any risk of getting the bends as man would.

Ringed seals have several natural enemies besides man - polar bear, Arctic fox, killer whales, and the walrus all consider them a source of food. Arctic fox generally hunt very young pups rather than adults by digging into the snow-covered seal pups' birth lairs. It is not known

what percentage of the ringed seal population dies of natural old age. Young pups and immature seals are occasionally killed naturally by being crushed in moving ice, or die by being trapped under ice without air.

It is difficult to estimate the birth and death rate for ringed seals. One study suggests an annual birth rate of about 15 percent of the total population, but pup mortality is uncertain and the fatality rate due to bears, whales and foxes is unknown. Ringed seals are an important source of food and clothing for Inuit communities. Virtually all of the animal is usable in some form.

In the mid-1960s the annual harvest of ringed seals by man was in the 70,000 range for the Canadian Arctic. In 1976 about 46,000 ringed seal pelts were shipped from the Northwest Territories, but it is not known what percent this represented of the total annual harvest. The Inuit employ a variety of methods to hunt seals, including shooting them as they surface for air at their breathing holes, or through cracks in the ice, or occasionally by setting nets in the ice cracks. In open water the seals are usually hunted from small boats with guns or harpoons.

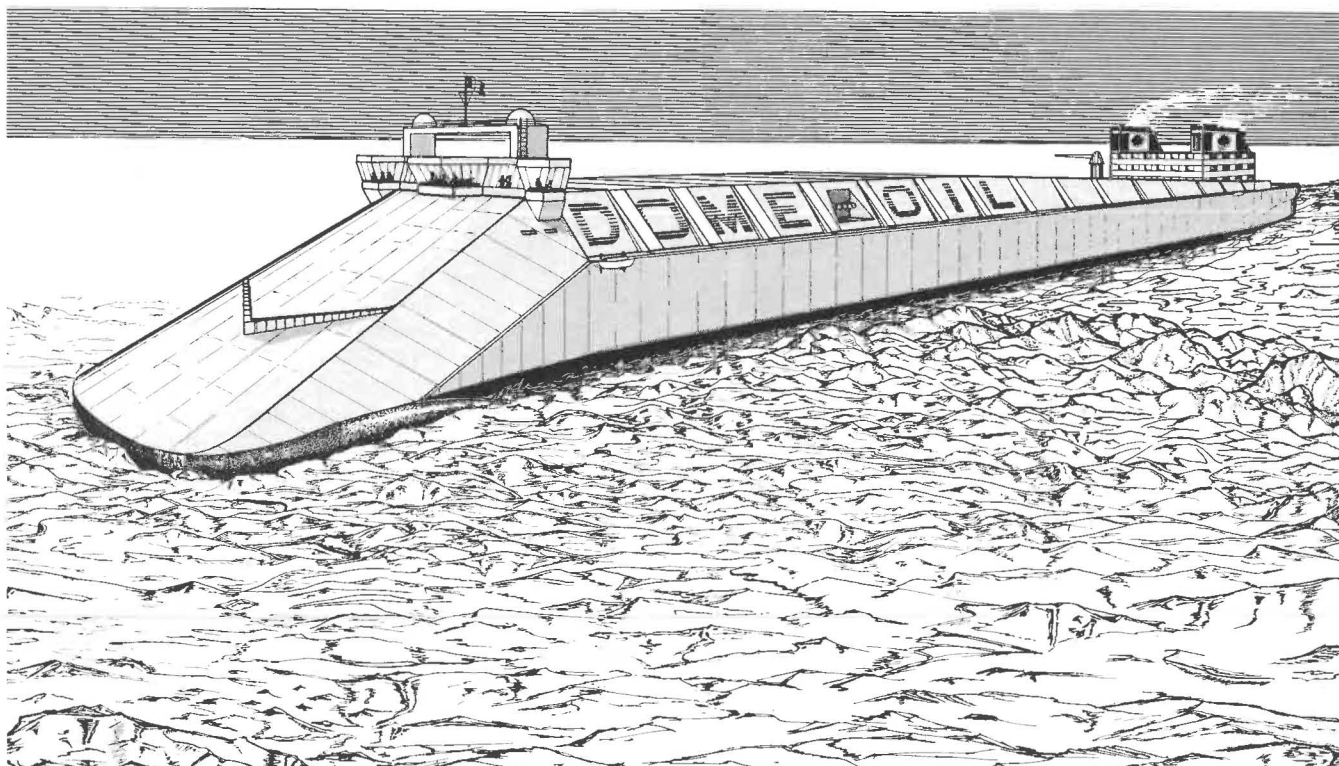
Because ringed seals are an important staple for Inuit communities and an abundant mammal in Arctic regions, the oil industry has participated in several scientific surveys to determine, among other things,

their distribution and population density. With information such as this, protective measures can be taken, if necessary, to minimize possible impacts of industrial activities. Aerial surveys of the High Arctic conducted in 1980 and 81 by the Canadian Wildlife Service are helping to establish where ringed seals tend to concentrate, particularly as related to proposed icebreaking tanker routes. Ringed seals are found to be most abundant in Wellington Channel and Barrow Strait, around Cornwallis Island, and northern Amundsen Gulf and Prince of Wales Strait near Banks Island. They seem to prefer higher ice floes that are not water soaked or ice floes just beginning to break up, especially first year ice.

Knowing the major concentration areas will allow industry to select tanker routes which will cause minimal interference with the seals and their habitat during sensitive periods. One of the main concerns is to avoid areas of abundant seal lairs during the birth and nursing period of about two months when the pups are most vulnerable. Since adult ringed seals and their pups tend to inhabit coastal fast ice areas, traffic should have only limited direct impact over most of the proposed tanker routes. During the open water season seals spend much of their time swimming. Based mainly upon casual observations from drillships, supply boats, etc., seals do not appear to be particularly disturbed by traffic while in the water. At most they might show a fright response, diving below the surface, only to reappear a short time later to see what is going on.

As noted in the opening of this article, ringed seals are a particularly important marine mammal in the Arctic. During the course of future development, industry must be able to ensure that the well-being of ringed seals, as well as the other mammals of the region, can and will be maintained. The ongoing research by government and industry, more and more with the help of native northerners, should contribute to achieving this key objective.

# Profile of an Arctic Tanker



*This sketch is an artist's conception of a future Arctic tanker to be used on a year-round basis through the Northwest Passage.*

The world's first oil tanker, the *Gluckauf*, was built in 1886, while the first icebreaker, the Russian *Paylot*, preceded it by some 22 years. Despite their relatively close design births, each type of ship has followed a unique path of development, based on very different roles. To create a year-round Arctic marine transportation system in the 1980s, the technologies of icebreakers and oil tankers are being combined, giving birth to a new generation of VLCC (Very Large Crude Carriers) ships with the best features of both. This Arctic tanker will not only be the most powerful icebreaker in the world, capable of sailing in all ice conditions 12 months a year, but will be the safest and most sophisticated oil tanker ever built.

## The Safety Record of VLCC Ships

Icebreakers have had a very good safety record over the past 110 years, but oil tankers, particularly in the more recent era of the 200,000 to 500,000 DWT (dead weight tonnage) supertankers, have had several serious accidents, a few of which resulted in adverse environmental consequences. In 1980 Dome Petroleum Limited commissioned Det norske Veritas of Norway, one of the leading ship classification societies in the world, to investigate the most serious of 178 incidents where more than 200 tons of oil were spilled. The findings on the 18 most significant accidents revealed causes which included groundings in shallow water,

collisions with other vessels, structural failure (often caused by rough weather) and explosions.

The majority of these accidents were found to be the result of human error, often compounded by design flaws, navigational breakdown, or mechanical failures. In designing the first Arctic tankers, the findings of this Det norske Veritas study are being applied to create a new class of ship where no single mistake, whether it be in design, operation, navigation, or mechanics, will lead to a disaster. The tankers will have built-in redundant features combined with unprecedented hull strengths for their class. This will mean that even a series of human errors and mechanical failures will not destroy the ship, or result in oil spillage into the Arctic environment.

## A Look at the Scale & Power of Arctic Tankers

In order to appreciate fully the features incorporated in this new generation of tankers, one needs to compare them against the large supertankers of conventional design and the most powerful present generation icebreakers. The prototype Arctic tanker will be large, but not nearly as large as ships like the Seawise Giant, a 564,700 DWT supertanker built in the late 1970s. The Arctic ships will have a cargo capacity of 200,000 DWT. A ship's dead weight tonnage, DWT, is the actual weight of the oil cargo, engine fuel, stores, and ballast that the ship can carry if loaded to the Plimsoll line on her hull. The total displacement weight of the Arctic tanker will be 300,000 tons. She will be 390 metres (1,280 feet) long, 52 metres (170 feet) wide, and have a draft of 20 metres (65½ feet).

The Russian built Arktika is

currently the most powerful icebreaker in the world. Her engines, powered by nuclear fission, generate 75,000 Shaft Horsepower (SHP). The Arctic tanker will have two independent engine and transmission systems producing up to 150,000 SHP. This is more than three times the power of a large conventional oil tanker, but considerably less than the 280,000 SHP used to propel U.S. Navy aircraft carriers of the Kittyhawk class.

The Arctic tanker will have twin screws and rudders, unlike many conventional tankers which are often limited in their manoeuvrability by a single propeller and rudder. Moreover, the propellers will be controllable in pitch and shrouded by steel rings, thereby providing much faster forward and reverse responses, as well as protection against ice.

The combination of more powerful engines with reversing pitch propellers results in an Arctic tanker capable of stopping in about 1000 metres (3,280 feet) in open water,

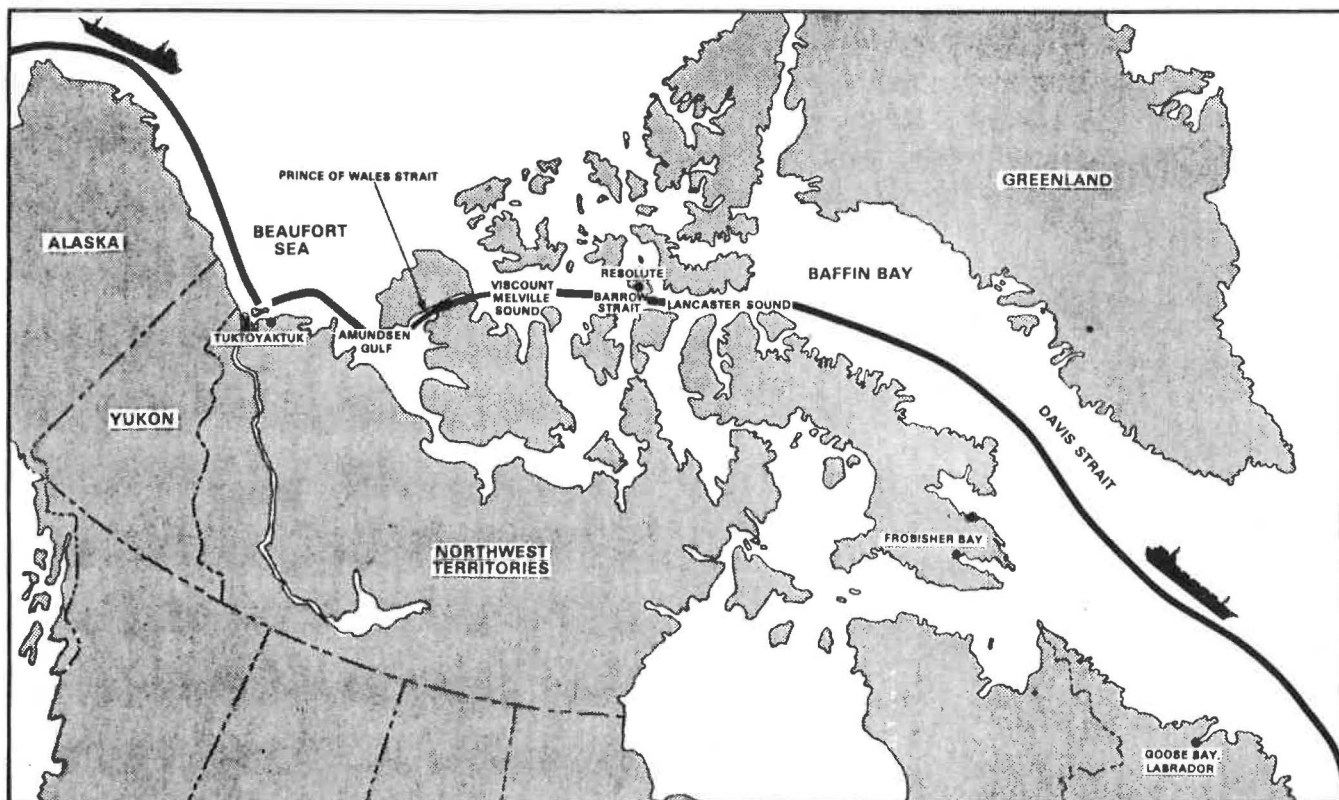
and much less than that in pack ice. By contrast a conventional single screw tanker can take up to 5 kilometres (3.1 miles) to stop from a cruising speed of 16 knots. Arctic tankers will achieve a cruising speed of 20 knots in open water, reducing to 6 knots while travelling through 3 metre (10 feet) thick ice.

This performance will exceed even the Class 10 standard for icebreakers. At present the Arktika has a Class 7 rating, and is capable of breaking 7 feet of ice while maintaining 3 knots. The first Canadian icebreaker to achieve the distinction of navigating through Arctic waters on a year-round basis is the Kigoriak, a forerunner of the Arctic tanker, and a testing laboratory for its many novel features.

## The Safety Features of the Tanker's Hull

To fulfill both icebreaking and oil cargo functions, the Arctic tanker

*The route an Arctic tanker will follow is illustrated on this map. Westbound (less likely in the near term), the tankers will pass the coast of Alaska and sail south into the Bering Sea. Eastbound tankers will generally travel through Prince of Wales Strait, Viscount Melville Sound, Barrow Strait, and Lancaster Sound, following along the east coast of Canada around Newfoundland.*





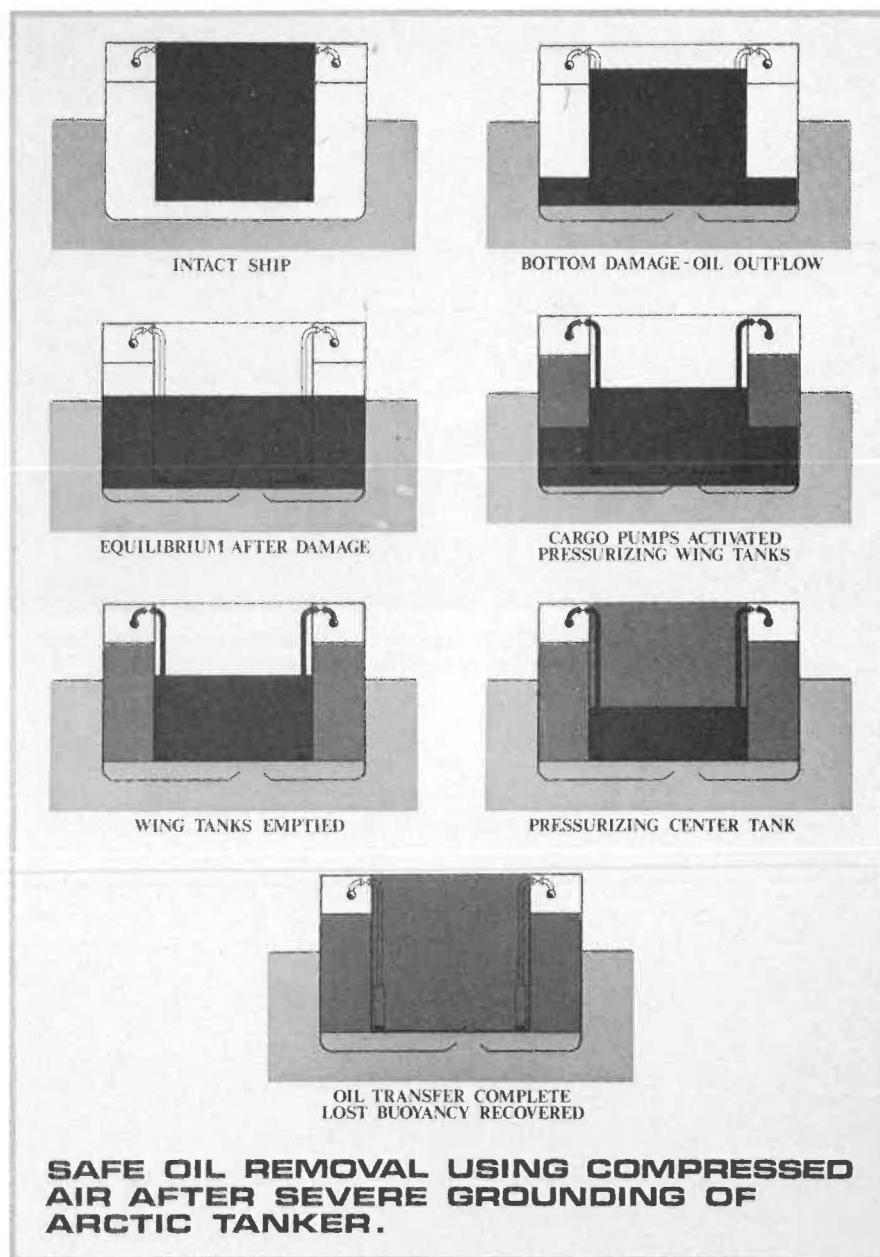
will have a double hull throughout - conventional tankers generally have a single layer of metal between the oil cargo and the ocean. This double hull, or "box within a box" principle, will have approximately 9 metre (30 feet) wide ballast compartments on the sides between the outside hull and inner cargo hold. The high tensile steel selected for the Arctic tanker will be thicker than that of any conventional tanker, and does not become brittle at low temperatures. Even the Arctic tanker's inner hull which contains the oil will be stronger than the hull of a 500,000 DWT supertanker.

In the remote event that both hulls of the Arctic tanker were penetrated, it is very unlikely that oil would leak out, since the ship has sufficient ballast volume to retain any spilled oil between the inner and outer skins. A compressed air system will be employed to compensate for any loss of buoyancy by pumping compressed air into the ballast tanks. Following this action, transfer pumps located within the damaged tanks can pump oil to undamaged, empty tanks, replacing that oil with more compressed air (see the accompanying illustration).

The Arctic tanker hull is estimated to be 14 times less likely to be penetrated than a regular ship should it be rammed, and collision with an iceberg will not rupture the inner cargo tanks. Naturally, it is not intended to challenge icebergs, even given this strength, but rather to navigate around them. Hydrodynamic design is as important as brute strength in ensuring trouble-free operation through Arctic ice. Based on model testing and the operational experience with the Kigoriak, the Arctic tanker will have a spoon-shaped bow with reamers, straight sides, and a highly refined stern to minimize ice interference with the shrouded propellers.

### Enhanced Manoeuvring for this Tanker

The reamers at the bow ensure that a channel is cut through the ice which is wider than the ship itself. This, combined with controlled



*Oil will be transferable from a damaged oil compartment in the Arctic tanker, by pumping compressed air into the ballast wing tanks, and then into the main compartment. In so doing the oil is displaced by air, and transferred into an adjacent empty tank. The wing tanks have sufficient volume to retain oil spills from a compartment inside the ship.*

ballasting, will greatly improve the Arctic tanker's turning capability. The prototype Kigoriak has been tested by controlling ballast, whereby water is pumped from one side to the other, permitting the ship to heel over. The Arctic tanker will be equipped with a more efficient heeling system which will enhance the ship's turning capabilities and aid it in breaking loose from ice.

To reduce the friction of the ship's hull, Kigoriak has been employing a water spray system - two high capacity pumps draw water from the sea, and spray it out of holes in the bow area onto the ice. The Arctic tanker, using this method, will reduce its ice resistance significantly in cold weather, by providing a lubricating water layer a few centimetres thick.



Arctic tankers will far exceed the strength required of conventional supertankers, such as this one, and will be 14 times less likely to be holed by ice than a conventional ship.



This is the largest icebreaker in world today, the Russian Class 7 Arktika, followed by a smaller vessel. It is powered by nuclear fission engines generating 75,000 SHP. This ship was the first in the world to sail to the North Pole, which it accomplished in August 1977. (Courtesy Novosti Press Agency, U.S.S.R.).

## Additional Safety Features

Carrying oil in tankers poses the potential threat of explosion. This is more likely to happen when the tanker's oil compartments are empty, and contain fumes. To minimize this possibility, the Arctic tanker will employ an inert gas system when sailing without oil. It will not have a separate pump room, common in conventional tankers, but rather independent deep-well pumps in each of its 14 oil tanks. This enhances safety during loading and unloading operations, avoids complex in-hull piping, and removes the risk of explosion in the pump room. As previously described, this design permits selective evacuation of individual oil tanks.

In yet another contrast to the conventional tanker, the Arctic tanker will have the navigation bridge forward rather than aft, allowing better visibility and navigational control. The captain will have "real time" strain gauge read-outs showing the actual stresses on the hull - permitting him to take any necessary actions well before structural damage might occur. He will have available a wealth of navigation, communications, and ice forecasting systems to plan his route, and to monitor weather and traffic conditions. (See our description of REMSCAN in this issue).

As part of its progressive technical development philosophy, Dome has tested various technical innovations with the Kigoriak. Refinements of these as well as totally new ideas are being incorporated in the design of other vessels such as Supplier 9, the round drillship, and the Arctic dredge. In this way experience and technology will continue to be combined to generate the optimum Arctic tanker design.

This decade will see not only a new kind of Arctic vessel sailing the Northwest Passage, but a dramatic new class of oil tanker which will set standards of excellence for safe marine transportation never previously attained. The best of both icebreakers and tankers will meld together to bring oil to Canadian markets.

# REMSCAN

## The Eyes and Ears of Arctic Tankers

REMSCAN is an abbreviation for remote sensing, communications and navigation, all essential functions for an Arctic tanker captain to have in order to sail the Northwest Passage. REMSCAN is first and foremost a safety system; one that will have redundant, back-up capabilities so that operations are never jeopardized.

Because the Arctic tanker will operate in the Northwest Passage year-round, it must have a remote sensing capability which can function in all weather conditions.

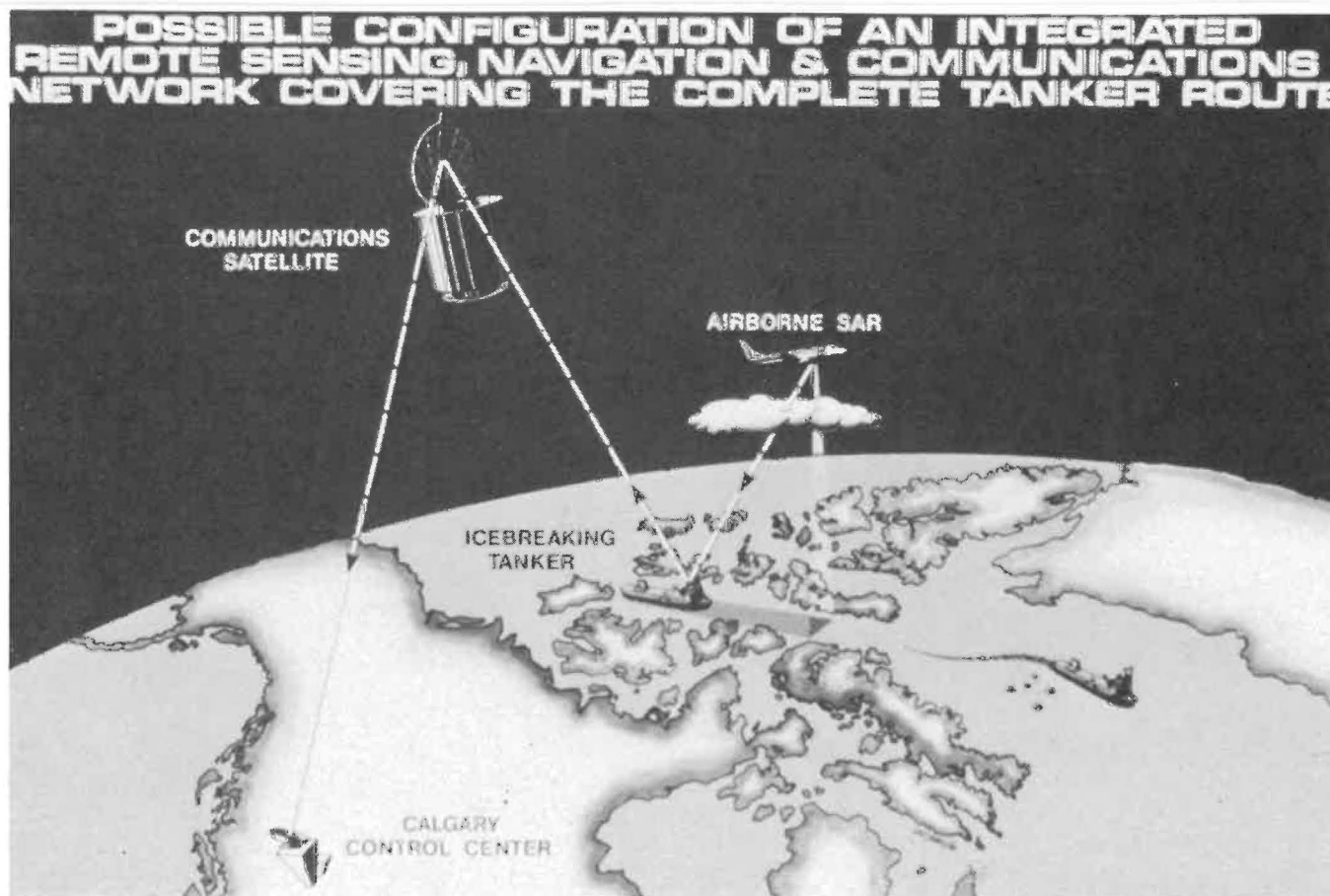
Twenty four hours a day it must detect and identify ice conditions in all locations along the Passage, regardless of the sea state or season.

Three levels of remote sensing support are planned. For long range, strategic route selection tanker captains will receive an encompassing view of ice conditions in the Canadian Arctic, projected over several days in advance of sailing. The other two levels of support involve what has been designated close-tactical and tactical remote

sensing. Close tactical refers to surveillance in the immediate vicinity of the vessel, with the objective of detecting small icebergs or other ice forms out to a range of at least 10 kilometres (6 miles).

Tactical remote sensing will appraise ice conditions up to 800 kilometres (500 miles) ahead of the ship, along a corridor from 30 to 200 kilometres (15 to 200 miles) wide. To meet all these demanding forecasts on a real-time basis, plus provide sophisticated navigation and communications for the tanker, a

*This artist's rendering illustrates how satellites, and airborne synthetic aperture radar, will provide the tactical and strategic forecasting necessary to operate Arctic tankers year-round through the Northwest Passage.*



combination of technical solutions will be applied.

For close-tactical support under all weather conditions, shipboard radar will, of course, be a prime component. However, experience with conventional marine radars has indicated limitations in their detection capability, depending upon the nature of the 'target', the sea state, and the weather conditions. The concept of an Advanced Marine Radar is being examined, with research and development programs projected which will result in a radar system tailored precisely for close-tactical surveillance. In addition to designing this radar specifically for that function, particular attention will be devoted to the enhancement of the radar signal data by an on-board computer system. The radar display screen will similarly be optimized for the close-tactical surveillance function.

In addition to radar, the Arctic

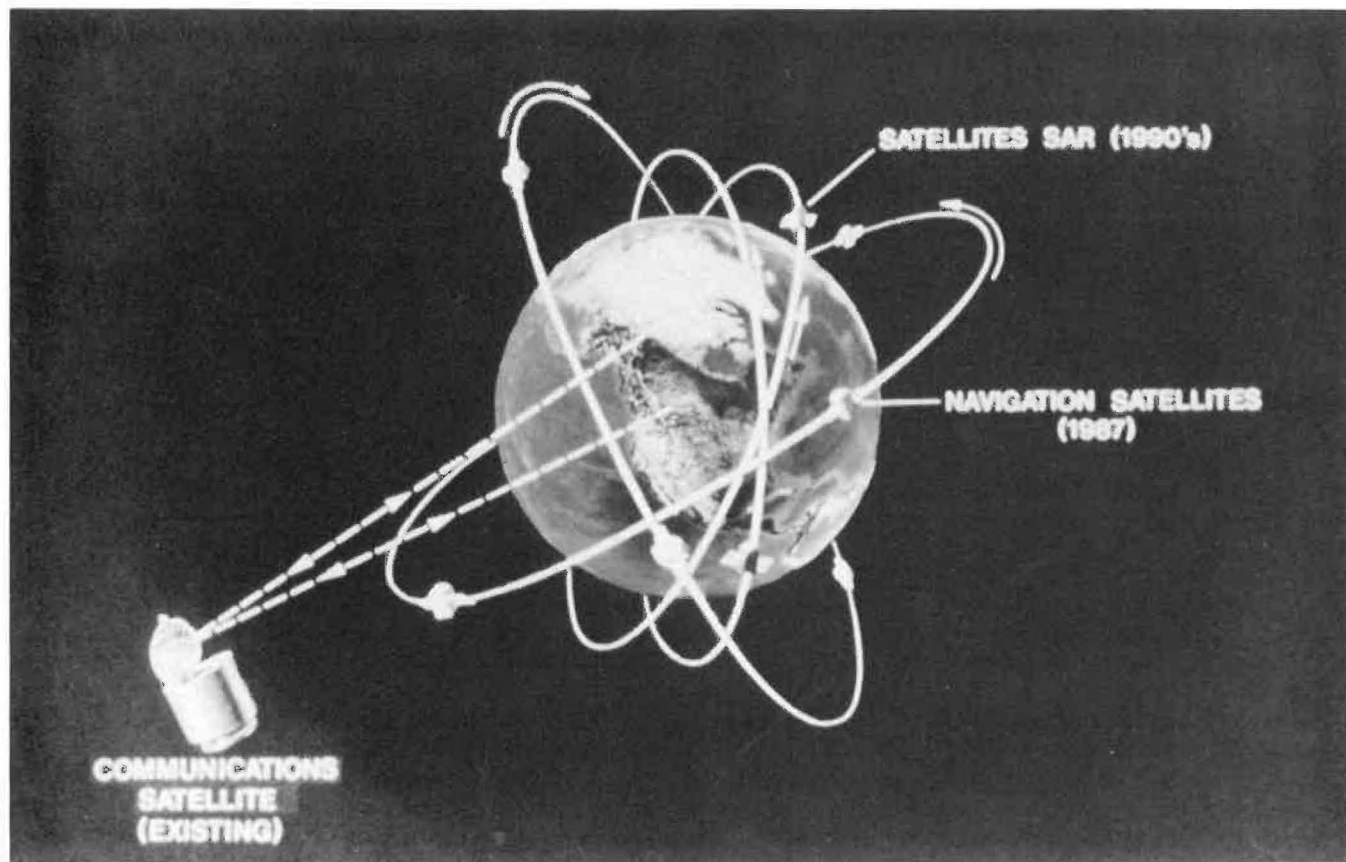
tanker will likely have several other kinds of sensors not commonly seen on civil vessels. The exact combination of technologies to be used will be determined by further study. At present the most promising include sonar scanners which bounce sound waves off the submerged part of ice floes, passive microwave or thermal infra-red scanners which can detect small temperature variations, and low light level optical devices.

The objective is to have a combination of technical systems which will reinforce each other - in conditions where radar performance may be degraded, thermal or sonar scanner, for example, would recover the lost performance. The combined data from these remote sensing systems will be displayed on a CRT (cathode ray tube) screen, giving the captain on the bridge a moving map of conditions in front of the tanker.

Longer range detection of ice conditions will utilize aircraft and satellites. The concept of detecting ice by high resolution radar from satellites has been proven, using a relatively short-lived, experimental satellite named SEASAT A. By the late 1980s Canada may have in orbit an operational satellite capable of scanning the High Arctic, transmitting maps showing ice conditions throughout the Northwest Passage. In conjunction with this, aircraft carrying high resolution, synthetic aperture radar (SAR), can photograph a corridor up to 80 kilometres (50 miles) wide in front of the tanker, and then transmit the photographs to the bridge of the ship or elsewhere.

The capability of airborne SAR has been demonstrated in the Beaufort Sea over the past three years, and plans are underway for development of a lightweight system specifically designed for operational

*Satellites will be valuable to the Arctic tanker for providing strategic remote sensing of ice conditions, communications and also to give precise navigation information. By the late 1980s and early 1990s GPS (Global Positioning System) satellites will provide world wide coverage, including the Arctic regions.*





use. Once vessel traffic becomes more common throughout the Northwest Passage, aircraft will carry out regular patrols, irrespective of season or weather. When satellite SAR becomes an operational reality, it will displace part of the airborne patrol, but it appears likely that the virtues of aircraft flexibility will make that method of surveillance important for the foreseeable future.

A central, shore-based communications headquarters will compile all the tactical and strategic remote sensing data, and will be in constant contact with ships sailing throughout the Arctic seas, helping captains plan the best possible routes, as well as maintaining an orderly traffic flow.

By the mid to late 1980s the primary navigation source is expected to be the 18 satellite Global Positioning System (also called NAVSTAR) being developed by the U.S. military. This system will

enable the Arctic tanker's navigators to know their position to an accuracy of about 100 metres (about 325 feet). The tankers will, of course, carry standard navigation equipment that will ensure at least double redundancy, in the event of an equipment failure.

To manoeuvre in confined areas, through narrow channels or when docking, the Arctic tanker will use a short-range radio positioning system. Radar reflector or transponders, mounted at strategic locations throughout the Northwest Passage, will give the ship's navigator a precise distance from the shoreline - this will be important when navigating in places such as the relatively narrow Prince of Wales Strait, located between Banks and Victoria islands.

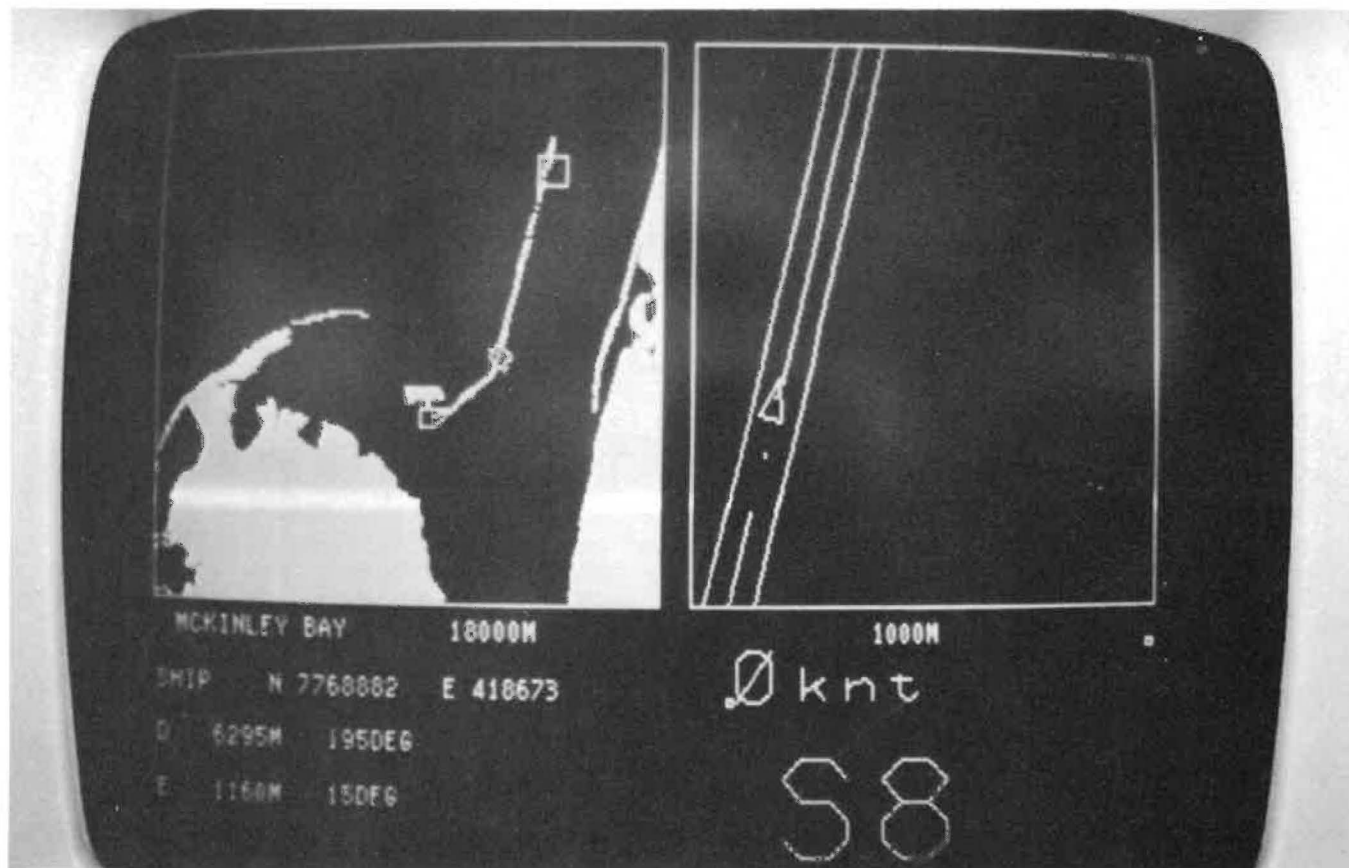
The Arctic tankers' combined navigation aids will considerably exceed the requirements of the Arctic Waters Pollution Prevention Act. Moreover,

there will be a collision avoidance and "off-course" alarm system connected to the ship's radar - should the ship deviate too far from its planned track, a warning signal would be activated on the bridge.

All ships sailing in the Northwest Passage will have a constant radio link between them, allowing captains to make strategic decisions as required. The Canadian Coast Guard is considering extending the NORDREG Vessel and Traffic Management System into all Arctic waters - this designates appropriate corridors for seasonal and year-round shipping routes. It also monitors and controls vessel traffic, giving pre-clearance for vessels entering Arctic waters, and enforcing operational procedures.

All of these systems combined should ensure the safest possible passage by icebreaking tankers through this important transportation corridor.

*This photo illustrates what a ship's captain sees on a typical CRT (cathode ray tube) screen presently in use on a supply vessel in the Beaufort. A similar system would be employed on the Arctic tanker. The left side shows the shoreline of McKinley Bay in the Beaufort, with the right, larger scale image showing the position of the ship in relation to a navigation corridor.*



# Icebreaker Track Research Program



*The icebreaker Kigoriak, followed by three Supplier vessels, sails out of the Arctic twilight during an experimental icebreaker track research program conducted in November and December of 1981 in the Beaufort Sea.*

The oil industry conducts research on a wide variety of environmental concerns that relate to its activities in the Canadian Arctic. One such concern is the ability of native hunters to travel across Arctic sea ice, following the passage of an icebreaker or Arctic tanker.

Since the beginning of time, hunters have been faced with the fickleness of ice, and the problems of traversing ice ridges and leads in the sea ice caused by nature. However, until recently there has been little scientific research on the effects of marine traffic on the ice and how this may affect traditional hunting routes over it.

In late 1981 the oil industry, working with the Hunters and Trappers Associations of the Beaufort region, initiated a testing program on the ice, along a route typically travelled by ice reinforced ships.

The team, headed by D. MacWatt, included four experienced hunters, D. Nasogaluak, E. Ruben, D. Inuktalik, and C. Mangelona, all from the Beaufort Sea region, and was supported from Tuktoyaktuk by D. Raddi and E. Raddi.

A test site was chosen which had a three day old ice track from a vessel. The track had refrozen into a multitude of varied size ice blocks which measured, on average, about 30 centimetres (12 inches). Using axes the native hunters quickly leveled off the larger blocks, and in a short time had smoothed off the track well enough to drive their skidoos across.

On this particular day, November 29th, the temperature was about -24 degrees Centigrade, with winds about 5 to 10 kmh (3 to 6 mph). The icebreaker Kigoriak, and four other Supplier vessels drove

through the ice within the space of 15 minutes. One half hour after their passage the research team and hunters approached the track site.

It was found that some of the larger blocks of ice churned up by the ships, more than 1/2 metre (2 feet) wide, could support a man; smaller blocks would sink slowly into the ice slush if stepped on. One hour after the ships' passage the slush between the ice chunks had frozen to a depth of 2 1/2 centimetres (one inch). This stabilized the traffic sufficiently to allow a man to cross it on foot.

Two and one half hours after the ships' passage the slush had refrozen to a five centimetre (2 inch) depth. A skidoo with a total weight of 300 kilograms (650 pounds) including the driver drove across the ice track with no sign of weakness in the ice.

A test was then conducted using a 560 kilogram (1,250 pounds) komatik (native sled) pulled by a skidoo across the ice track. Initially the komatik moved well; however, after riding over a rather large block of ice it dropped about 30 centimetres (12 inches) onto the refrozen slush.

The ice failed under the komatik, but did not break through. The sled continued to be pulled along in a 10 to 20 centimetre (6 inch) depression which moved like a wave underneath, although there was no water visible in the depression.

Following this, the ice track was no longer considered safe to cross again immediately at that particular location. The participating hunters advised the researchers that this experience was common knowledge among the native hunters, and they never follow directly behind another skidoo in weak ice conditions.

The icebreaker track research program is continuing; should problems be uncovered, the next step will be to develop satisfactory solutions.



*Experienced hunters of the northern region and research scientists combined skills during the testing program, which was intended to see how quickly a ship's track could be safely traversed following a passage.*



*Crossing a ship's track such as shown here will require care, but probably not unlike that employed routinely in crossing naturally rough or new ice areas.*



*The Pierre Radisson is one of eight heavy icebreakers operated by the Canadian Coast Guard. It is an Arctic Class 3 icebreaking vessel which spends about four months of the year in Arctic waters. The ship, which is based in Quebec City, has a complement of 57, a full load displacement of 7,721 metric tons, and can cruise at 13 knots. Powered by engines producing 13,600 shaft horsepower, the Pierre Radisson, along with her sister ship, Sir John Franklin, was built in Vancouver, B.C. in the late 1970s. The icebreakers have their own helicopter, a Bell 206, and a full time helicopter pilot on board.*

